

## CLAIMS:

What is claimed is:

1. A method for enhancing dynamic range of data read from an imaging sensor, said imaging sensor comprising N linear pixel arrays, each of the N linear arrays having M charge coupled pixels, each pixel charge coupled, and further being coupled to one of N registers, the method comprising:
  - integrating charge in at least some pixels of the N linear pixel arrays;
  - combining charge from a first region of the N linear pixel arrays of the imaging sensor in the N registers by shifting charge from the first region along each of the N linear pixel arrays to each of the N registers, said first region of the N linear pixel arrays having at least one pixel line and said at least one pixel line of the first region is oriented in generally orthogonal direction to the N linear pixel arrays;
  - shifting charge from the N registers along a linear path;
  - representing charge from at least a portion of the first region of the N linear pixel arrays, shifted out of the N registers, as a corresponding portion of N first region data signals;
  - combining charge from a second region of the N linear pixel arrays in the N registers by shifting charge from said at least one pixel line of the second region along each of the N linear pixel arrays to each of the N registers, said second region having at least one pixel line, and said at least one pixel line of the second region is oriented in generally orthogonal direction to the N linear pixel arrays;
  - shifting charge from the N registers along a linear path; and
  - representing charge from at least a portion of the second region of the N linear pixel arrays, shifted out of the N registers, as a corresponding portion of N second region data signals.

- 1 2. The method for increasing dynamic range recited in claim 1 above further  
2 comprises:
- 3 presenting said portion of N first region data signals; and  
4 presenting said portion of N second region data signals.
- 1 3. The method for increasing dynamic range recited in claim 2 above, wherein said  
2 first portion comprises N first region data signals and said second portion comprises N  
3 second region data signals.
- 1 4. The method for increasing dynamic range recited in claim 1 above further  
2 comprises:
- 3 defining the first region of the N linear pixel arrays of the imaging sensor by  
4 designating at least one pixel line as belonging to the first region of the N linear pixel  
5 arrays.
- 1 5. The method for increasing dynamic range recited in claim 4 above, wherein  
2 defining the first region of the N linear pixel arrays of the imaging sensor by designating  
3 at least one pixel line as belonging to the first region of the N linear pixel arrays further  
4 comprises:
- 5 assessing a level of improvement in dynamic range in at least one signal taken  
6 from the portion of N first region data signals, and the portion of N second region data  
7 signals; and  
8 determining an amount of pixel lines belonging to the first region of the N linear  
9 pixel arrays for improving the dynamic range in the at least one signal, wherein said  
10 amount of pixel lines relates to the level of improvement in dynamic range.

1 6. The method for increasing dynamic range recited in claim 4 above, wherein  
2 defining the first region of the N linear pixel arrays of the imaging sensor by designating  
3 at least one pixel line as belonging to the first region of the N linear pixel arrays further  
4 comprises:

5 setting at least one target signal level;

6 selecting at least one signal from one of the portion of N first region data signals  
7 and the portion of N second region data signals;

8 comparing the selected at least one signal to the at least one target signal level;  
9 and

10 adjusting an amount of pixel lines belonging to the first region of the N linear  
11 pixel arrays, wherein said adjustment is based on the comparison of the selected at least  
12 one signal to the at least one target signal level.

1 7. The method for increasing dynamic range recited in claim 6 above, wherein  
2 adjusting an amount of pixel lines belonging to the first region of the N linear pixel arrays  
3 further comprises altering the amount of pixel lines belonging to the first region by a  
4 predetermined proportion of the amount of pixel lines.

1 8. The method for increasing dynamic range recited in claim 6 above, wherein  
2 adjusting an amount of pixel lines belonging to the first region of the N linear pixel arrays  
3 further comprises altering the amount of pixel lines belonging to the first region by a  
4 predetermined number of pixel lines.

1 9. The method for increasing dynamic range recited in claim 6 above further  
2 comprises modifying an amount of pixel lines belonging to the second region based on  
3 the sum of pixel lines in the first region and second region being equivalent to an amount  
4 of pixels in any one of the N linear arrays.

1 10. The method for increasing dynamic range recited in claim 9 above, wherein said  
2 amount of pixels in each of the N linear arrays is M pixels.

1 11. The method for increasing dynamic range recited in claim 9 above further  
2 comprises:

3 integrating charge in at least some pixels of the N linear pixel arrays;

4 combining charge from the first region of the N linear pixel arrays of the imaging  
5 sensor in the N registers by shifting charge from said adjusted amount of pixel lines of  
6 the first region along each of the N linear pixel arrays to each of the N registers;

7 shifting charge from the N registers along a linear path;

8 representing charge from at least a portion of the first region of the N linear pixel  
9 arrays, shifted out of the N registers, as a corresponding portion of N first region data  
10 signals;

11 combining charge from the second region of the N linear pixel arrays in the N  
12 registers by shifting charge from said modified amount of pixel second region along each  
13 of the N linear pixel arrays to each of the N registers; and

14 shifting charge from the N registers along a linear path; and

15 representing charge from at least a portion of the second region of the N linear  
16 pixel arrays, shifted out of the N registers, as a corresponding portion of N second region  
17 data signals.

1 12. The method for increasing dynamic range recited in claim 6 above, wherein said  
2 adjustment based on the comparison of the selected at least one signal to the at least one  
3 target signal level relates to difference between the selected at least one signal to the at  
4 least one target signal level.

1 13. The method for increasing dynamic range recited in claim 6 above, wherein the at  
2 least one target signal is a range of target signal levels, and said adjustment based on the  
3 comparison of the selected at least one signal to the at least one target signal level relates  
4 to a difference between the selected at least one signal to the range of target signal levels.

1 14. The method for increasing dynamic range recited in claim 4 above, wherein  
2 defining the first region of the N linear pixel arrays of the imaging sensor is  
3 accomplished during a setup phase of a device incorporating said imaging sensor.

1 15. The method for increasing dynamic range recited in claim 4 above, wherein  
2 defining the first region of the N linear pixel arrays of the imaging sensor is  
3 accomplished dynamically, following said integrating charge in at least some pixels of  
4 the N linear pixel arrays, and prior to a subsequent integration of charge in at least some  
5 pixels of the N linear pixel arrays.

1 16. The method for increasing dynamic range recited in claim 1 above further  
2 comprises:  
3       presenting said portion of N first region data signals as a first channel of small-  
4 amplitude signals; and  
5       presenting said portion of N second region data signals as a second channel of  
6 large-amplitude signals.

1 17. The method for increasing dynamic range recited in claim 16 above further  
2 comprises:  
3       re-scaling one of said small-amplitude signals from said first region and said  
4 large-amplitude signals from said second region.

1 18. The method for increasing dynamic range recited in claim 17 above, wherein re-  
2 scaling one of said small-amplitude signals from said first region and said large-

3 amplitude signals from said second region is based on a scale of the other of said small-  
4 amplitude signals from said first region and said large-amplitude signals from said second  
5 region.

1 19. The method for increasing dynamic range recited in claim 16 above further  
2 comprises:

3 determining a relationship between said small-amplitude signals of said first  
4 channel from said first region, and said large-amplitude signals of said second channel  
5 from said second region.

1 20. The method for increasing dynamic range recited in claim 19 above further  
2 comprises:

3 applying said relationship to the corresponding at least one data signal from the N  
4 data signals representing charge from the first region of the N linear pixel arrays; and

5 replacing said at least one of the N data signals representing a saturated condition  
6 from the second region of the N linear pixel arrays.

1 21. The method for increasing dynamic range recited in claim 20 above, wherein each  
2 of said N linear pixel arrays corresponds to a wavelength channel of an N wavelength  
3 channel spectrum and each of said N data signals representing an amplitude of said N  
4 wavelength channels of the spectrum.

1 22. The method for increasing dynamic range recited in claim 21 above further  
2 comprises:

3 presenting as a wide dynamic-range spectrum, the data signals from the second  
4 channel of large-amplitude signals representing charge from said second region, and, the  
5 corresponding at least one data signal from the N data signals representing charge from  
6 the first region of the N linear pixel arrays replacing said at least one of the N data signals  
7 representing a saturated condition from the second region of the N linear pixel arrays.

1 23. The method for increasing dynamic range recited in claim 1 above, wherein a  
2 corresponding each of said portion of N first region data signals and each of said portion  
3 of N second region data signals both correspond to at least one discrete wavelength.

1 24. The method for increasing dynamic range recited in claim 1 above further  
2 comprises:

3 combining a part of said portion of N first region data signals with a non-  
4 corresponding part of said portion of N second region data signals; and

5 presenting the part of said portion of N first region data signals and the non-  
6 corresponding part of said portion of N second region data signals as a plurality of data  
7 signals.

1 25. An imaging apparatus having enhancing dynamic range comprising:  
2 an imaging sensor comprising:  
3 N linear arrays, each of the N linear arrays having M charge coupled  
4 pixels;  
5 M pixel lines, said M pixel lines being oriented in generally orthogonal  
6 direction to the N linear pixel arrays;  
7 N registers, wherein one pixel in each of the N linear pixel arrays being  
8 charge coupled to a respective one of the N registers;  
9 signal converter connected to at least one of said N registers for  
10 representing a charge as a data signal; and  
11 an output node coupled to said signal converter ;  
12 a memory connected to said output node;  
13 a readout controller coupled to said imaging sensor for controlling readout of said  
14 M charge coupled pixels in all the N linear pixel arrays; and  
15 means for instructing said readout controller for combining charge from a first  
16 region of the N linear pixel arrays of the imaging sensor in the N registers by shifting  
17 charge from the first region along each of the N linear pixel arrays to each of the N  
18 registers, said first region of the N linear pixel arrays having at least one pixel line, and  
19 for shifting charge from the N registers along a linear path to said signal converter, and  
20 for transferring said N first region data signals to said memory, and further for instructing  
21 said readout controller for combining charge from a second region of the N linear pixel  
22 arrays of the imaging sensor in the N registers by shifting charge along each of the N  
23 linear pixel arrays to each of the N registers and for shifting charge from the N registers  
24 along a linear path to said signal converter, and for transferring said N second region data  
25 signals to said memory.



1 26. The imaging apparatus recited in claim 25 above, wherein said memory being  
2 coupled to a display device.

1 27. The imaging apparatus recited in claim 25 above, wherein said means for  
2 instructing alters an amount of pixel lines in a region prior to instructing said readout  
3 controller.

1 28. A computer program product, comprising a computer-readable medium having  
2 stored thereon computer executable instructions for implementing a method for  
3 enhancing dynamic range of data read from an imaging sensor having a controller that  
4 executes a plurality of reordered commands, said computer executable instructions  
5 comprising:

6 instructions for integrating charge in at least some pixels of the N linear pixel  
7 arrays;

8 instructions for combining charge from a first region of the N linear pixel arrays  
9 of the imaging sensor in the N registers by shifting charge from the first region along  
10 each of the N linear pixel arrays to each of the N registers, said first region of the N linear  
11 pixel arrays having at least one pixel line and said at least one pixel line of the first region  
12 is oriented in generally orthogonal direction to the N linear pixel arrays;

13 instructions for shifting charge from the N registers along a linear path;

14 instructions for representing charge from at least a portion of the first region of  
15 the N linear pixel arrays, shifted out of the N registers, as a corresponding portion of N  
16 first region data signals;

17 instructions for combining charge from a second region of the N linear pixel  
18 arrays in the N registers by shifting charge from said at least one pixel line of the second  
19 region along each of the N linear pixel arrays to each of the N registers, said second  
20 region having at least one pixel line, and said at least one pixel line of the second region  
21 is oriented in generally orthogonal direction to the N linear pixel arrays; and

22 instructions for shifting charge from the N registers along a linear path; and

23 instructions for representing charge from at least a portion of the second region of  
24 the N linear pixel arrays, shifted out of the N registers, as a corresponding portion of N  
25 second region data signals.

- 1 29. The computer program product recited in claim 28 above further comprises:  
2 instructions for defining the first region of the N linear pixel arrays of the imaging  
3 sensor by designating at least one pixel line as belonging to the first region of the N linear  
4 pixel arrays.
- 1 30. The computer program product recited in claim 29 above further comprises:  
2 instructions for assessing a level of improvement in dynamic range in at least one  
3 signal taken from the portion of N first region data signals, and the portion of N second  
4 region data signals; and  
5 instructions for determining an amount of pixel lines belonging to the first region  
6 of the N linear pixel arrays for improving the dynamic range in the at least one signal,  
7 wherein said amount of pixel lines relates to the level of improvement in dynamic range.
- 1 31. The computer program product recited in claim 29 above further comprises:  
2 instructions for setting at least one target signal level;  
3 instructions for selecting at least one signal from one of the portion of N first  
4 region data signals and the portion of N second region data signals;  
5 instructions for comparing the selected at least one signal to the at least one target  
6 signal level; and  
7 instructions for adjusting an amount of pixel lines belonging to the first region of  
8 the N linear pixel arrays, wherein said adjustment is based on the comparison of the  
9 selected at least one signal to the at least one target signal level.
- 1 32. The computer program product recited in claim 31 above further comprises:  
2 instructions for altering the amount of pixel lines belonging to the first region by a  
3 predetermined proportion of the amount of pixel lines.

1 33. A method for reading data from an imaging sensor, said imaging sensor  
2 comprising N linear pixel arrays, each of the N linear arrays having M charge coupled  
3 pixels, each pixel charge coupled, and further being coupled to one of N registers, the  
4 method comprising:

5 defining a first region of the N linear pixel arrays of the imaging sensor, said first  
6 region having at least one pixel line and said at least one pixel line is oriented in  
7 generally orthogonal direction to the N linear pixel arrays;

8 defining a second region of the N linear pixel arrays of the imaging sensor, said  
9 second region having at least one pixel line and said at least one pixel line is oriented in  
10 generally orthogonal direction to the N linear pixel arrays;

11 defining a dark region of the N linear pixel arrays of the imaging sensor, said dark  
12 region having a plurality of pixel lines, said plurality of pixel lines are oriented in  
13 generally orthogonal direction to the N linear pixel arrays and said plurality of pixel lines  
14 are not exposed to light;

15 receiving a first image on at least some pixels of the first region of the N linear  
16 pixel arrays;

17 receiving a second image on at least some pixels of the second region of the N  
18 linear pixel arrays;

19 integrating charge in the at least some pixels of the first region of the N linear  
20 pixel arrays and in the at least some pixels of the second region of the N linear pixel  
21 arrays;

22 shifting charge from the at least some pixels of the first region and second region  
23 of the N linear pixel arrays along a linear path into said dark region of the N linear pixel  
24 arrays of the imaging sensor; and

25 reading out charge from said dark region, said charge from said dark region  
26 having been shifted from each region defined on the N linear pixel arrays of the imaging  
27 sensor.

1 34. The method for reading data recited in claim 33 above, wherein, for each region,  
2 reading out charge from said dark region further comprises:

3 combining charge integrated in a region of the N linear pixel arrays of the  
4 imaging sensor in the N registers by shifting charge from the dark region along each of  
5 the N linear pixel arrays to each of the N registers;

6 shifting charge from the N registers along a linear path; and

7 representing charge from at least a portion of the region of the N linear pixel  
8 arrays, shifted out of the N registers, as a corresponding portion of N data signals  
9 associated with the region.

1 35. The method for reading data recited in claim 34 above further comprises:

2 shifting charge from the dark region of the N linear pixel arrays of the imaging  
3 sensor in the N registers; and

4 discarding the charge shifted from the dark region of the N linear pixel arrays of  
5 the imaging sensor.

1 36. The method for reading data recited in claim 34 above, wherein the first region is  
2 further defined as a third region and a fourth region of the N linear pixel arrays of the  
3 imaging sensor.

1 37. The method for reading data recited in claim 36 above further comprises:

2 presenting said corresponding portion of N first region data signals; and

3 presenting said corresponding portion of N second region data signals.

- 1 38. The method for reading data recited in claim 37 above, wherein presenting said  
2 portion of N first region data signals further comprises:
- 3       presenting said corresponding portion of N third region data signals; and  
4       presenting said corresponding portion of N fourth region data signals.
- 1 39. The method for reading data recited in claim 33, wherein a sum of the pixel lines  
2 defined in said first region, said second region and said dark region comprises at least M  
3 pixel lines.
- 1 40. The method for reading data recited in claim 39, wherein said plurality of pixel  
2 lines of the dark region of the N linear pixel arrays is defined as at least  $M/2$  pixel lines.

1 41. A method for reading data from an imaging sensor, said imaging sensor  
2 comprising N linear pixel arrays, each of the N linear arrays having M charge coupled  
3 pixels, each pixel charge coupled, and further being coupled to one of N registers, the  
4 method comprising:

5 integrating charge in at least some pixels of a first region of the N linear pixel  
6 arrays and at least some pixels of a second region of the N linear pixel arrays, said first  
7 region of the N linear pixel arrays having at least one pixel line and said at least one pixel  
8 line of the first region is oriented in generally orthogonal direction to the N linear pixel  
9 arrays, said second region of the N linear pixel arrays having at least one pixel line and  
10 said at least one pixel line of the second region is oriented in generally orthogonal  
11 direction to the N linear pixel arrays;

12 shifting charge from the at least some pixels of the first and second regions of the  
13 N linear pixel arrays along a linear path into a dark region of the N linear pixel arrays of  
14 the imaging sensor, said dark region of the N linear pixel arrays having at least two pixel  
15 lines, said at least two pixel lines of the dark region are oriented in generally orthogonal  
16 direction to the N linear pixel arrays and are not exposed to light;

17 combining charge integrated in the first region of the N linear pixel arrays of the  
18 imaging sensor in the N registers by shifting charge from the dark region along each of  
19 the N linear pixel arrays to each of the N registers;

20 shifting charge from the N registers along a linear path;

21 representing charge from at least a portion of the first region of the N linear pixel  
22 arrays, shifted out of the N registers, as a corresponding portion of N first region data  
23 signals;

24 combining charge integrated in the second region of the N linear pixel arrays of  
25 the imaging sensor in the N registers by shifting charge from the dark region along each  
26 of the N linear pixel arrays to each of the N registers;

27           shifting charge from the N registers along a linear path;  
28           representing charge from at least a portion of the second region of the N linear  
29 pixel arrays, shifted out of the N registers, as a corresponding portion of N second region  
30 data signals; and  
31           clearing charge from the dark region of the N linear pixel arrays of the imaging  
32 sensor.

1   42.    The method for reading data recited in claim 41 above further comprises:

2           presenting said portion of N first region data signals; and

3           presenting said portion of N second region data signals.

1   43.    The method for reading data recited in claim 42 above, wherein said first portion  
2 comprises N first region data signals and said second portion comprises N second region  
3 data signals.

1   44.    The method for increasing dynamic range recited in claim 41 above, wherein  
2 integrating charge in at least some pixels of a first region of the N linear pixel arrays and  
3 at least some pixels of a second region of the N linear pixel arrays, further comprises:

4           accumulating charge in the at least some pixels of the first and second regions of  
5 the N linear pixel arrays for a predetermined time period.

1   45.    The method for reading data recited in claim 41 above, wherein clearing charge  
2 from the dark region of the N linear pixel arrays further comprises:

3           shifting charge from the dark region of the N linear pixel arrays of the imaging  
4 sensor in the N registers; and

5           discarding the charge shifted from the dark region of the N linear pixel arrays of  
6 the imaging sensor.



1 46. The method for reading data recited in claim 41, wherein the dark region of the N  
2 linear pixel arrays comprises a quantity of pixel lines at least as great as a sum of said at  
3 least one pixel line of the first region and said at least one pixel line of the second region.

1 47. The method for reading data recited in claim 41, wherein the dark region of the N  
2 linear pixel arrays comprises at least  $M/2$  pixel lines.

1 48. The method for reading data recited in claim 41, wherein said first region of the N  
2 linear pixel arrays having a first image projected thereon, and said second region of the  
3 N linear pixel arrays having a second image projected thereon.

1 49. The method for reading data recited in claim 41, wherein said first region of the N  
2 linear pixel arrays being exposed to a first light source, and said second region of the N  
3 linear pixel arrays being exposed to a second light source.

1     50.     The method for reading data recited in claim 41 above further comprises:  
2             integrating charge in at least some pixels of at least one other region of the N  
3     linear pixel arrays, each of said at least one other region of the N linear pixel arrays  
4     having at least one pixel line and said at least one pixel line of said at least one other  
5     region of the N linear pixel arrays is oriented in generally orthogonal direction to the N  
6     linear pixel arrays;  
7             shifting charge from the at least some pixels of said at least one other region of  
8     the N linear pixel arrays along a linear path into a dark region of the N linear pixel arrays  
9     of the imaging sensor;  
10            for each of the at least one other region of the N linear pixel arrays, combining  
11    charge integrated in one of the at least one other region of the N linear pixel arrays by  
12    shifting charge from the dark region along each of the N linear pixel arrays to each of the  
13    N registers; and  
14            shifting charge from the N registers along a linear path.